the screws of the Maxwell top, the analytical complexity in chap. xvii. defied a Weierstrass, who handed his difficulties over to the young Kowalevski, to break her teeth over the problem.

The ardent spirit is not deterred, but, on the contrary, rather stimulated, to tackle a question declared intractable; so Prof. Gray gives a *résumé* in chap. xvii. of the progress made so far by other daring mathematicians—Russians for the most part—although we miss a figure and description of the Maxwell top, to be placed on the table in front and twirled by a finger and thumb.

The spherical pendulum of chap. xv. was early to receive attention as a problem in mere particle dynamics, realised in swinging a plummet about at the end of a thread. This is a case of gyroscopic-top motion where the component angular momentum (A.M.) about the axle is zero, and is realised in the apparatus of Fig. 30(*b*) by projecting the wheel without rotation. But this limitation makes the motion very uninteresting analytically, except as illustrating a solution of a Lamé equation of the second order. The simple case of holding out the axle horizontal, and projecting it horizontally without any rotation of the wheel, is of interest as giving a state of motion that has a simple analytical solution, which may be written down here:

$$\sin\theta\cos(\psi - ht) = \sqrt{(\sec\theta_3 - \cos\theta_3)}\sqrt{(\cos\theta)},$$
$$\sin\theta\sin(\psi - ht) = \sqrt{(\cos\theta_3 - \cos\theta . \cos\theta + \sec\theta_3)},$$

where $2h$ denotes the precession when the axle is horizontal, and θ_3 is the extreme angle of the axle with the downward vertical, to which the axle sinks and then rises up again to the horizontal.

This can serve as a penultimate case where the spherical pendulum is whirled round swiftly, apparently in a horizontal circle, as with the lariat or bola, as on p. 302, contrasted with swift whirling in a vertical circle, penultimate case of pendulum motion, and an extreme contrast to small plane oscillation near the vertical.

Lagrange came to grief over the small conical oscillations of the spherical pendulum (*cf.* § 5, p. 302), yet he could have saved himself and detected his error but for the self-imposed restraint of excluding the diagram from his "Mécanique analytique." So it is curious to find the same fashion coming again in the modern school of pure analytical treatment, of doing away with an appeal to the visual sense of a geometrical figure.

In swift rotation about an axis in the neighbourhood of a principal axis, as the axis of figure of a symmetrical top, the instantaneous axis does not wander far from the principal axis, and the axis of A.M. keeps close by also, even when the body, like the top, is acted on continuously by a force or couple which causes the A.M. vector to move.

The kindergarten explanation of top motion, in considering only the rotation about the axis, can then be made more exact, when it is assumed that the divergence of the axis of A.M. and angular velocity from the axis of figure is always small, so that one may be used indiscriminately for the other.

In this way, by calling CR the A.M. above the axis of figure, and $gMh\sin\theta$ the couple of gravity on the top when the axis points up at an angle θ with the upward vertical, the simple formula is obtained for μ, the precession:

$$\mu CR\sin\theta = gMh\sin\theta, \quad \mu = \frac{gMh}{CR},$$

provided θ is not too small.

Poinsot applied the same principle in his treatment of precession and nutation ("Connaissance des temps," 1858), assuming the divergence of the axis of rotation and of A.M. from the axis of figure of the earth as insensible; otherwise we should see the stars dancing about. The treatment here in chap. x. could be simplified in Poinsot's method. The Glasgow problem on p. 13 of the calculation of the diameter of the earth's axis at the pole may be cited as a justification of Poinsot's assumption.

It was a mathematical genius who changed in precession to the reckoning in $\frac{A, C}{C-A} = 304, 305$, or some say 305, 306, instead of the usual reciprocals in small decimals, indistinguishable numerically. And we venture to put in a plea for the sidereal day as the unit of time in these measurements, and not the solar year, thus making $R = 2\pi$ for the earth.

The effect of precession is to shorten the year about twenty minutes, and thus the period is 26,000 years of a complete revolution of the equinox through the stars. The classical scholar may be encouraged to take up the study of Astronomy when he hears that stray references to the stars by Homer are a guide to us in assigning limits to the age in which he lived and wrote. Astronomy was a much more living, actual interest in the days before clock and watch was so plentiful.

G. Greenhill.

A PHYSIOLOGIST'S CONTRIBUTION TO WAR SURGERY.

Intravenous Injection in Wound Shock. Being the Oliver-Sharpey Lectures delivered before the Royal College of Physicians of London in May, 1918. By Prof. W. M. Bayliss. Pp. xi+172. (London: Longmans, Green, and Co., 1918.) Price 9*s.* net.

THE war has brought into touch with directly practical problems many whose interests, before its outbreak, lay in fields of investigation which were popularly regarded as purely academic and remote from contact with everyday needs. In no department of research has the value of "pure" science been more finely vindicated than in that of physiology; and the gain to both physiology and practical medicine from this closer alliance of theory and application has been the subject of general remark. There could scarcely be a better example of this recent tendency than Prof. Bayliss's book on the treatment of "wound shock," which embodies, with much added detail and illustration, the substance of his

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Oliver-Sharpey lectures, delivered before the Royal College of Physicians in 1918.

The subject of "shock" was one which offered little attraction, under normal conditions, to the laboratory worker, with his habit of precision in nomenclature and his love of the clearly defined problem. To the surgeon the problem was a sufficiently definite and urgent one, but there was always the suspicion, not even yet dispelled, that the term covered any condition in which the vital functions suffered rapid depression, and that the common factor was obscurity of causation. The same applied to "wound shock" in the earlier stages of the war, but Prof. Bayliss shows how the co-ordinated efforts of physiologists working at home and surgeons working in the clearing stations succeeded in reducing the complexity of the problem. He shows that the question of causation has by no means yet received a final answer; it is still obvious that the contributory factors are numerous, and that their relative importance varies widely from case to case. The central feature of the condition, however, is constant—a deficient volume of the blood in effective circulation. In the large majority of cases the loss has a twofold origin; blood has been lost from the system by actual hæmorrhage, and of what remains part is rendered ineffective for the needs of the body by the tendency to stagnation in the peripheral vessels. In the production of this latter phenomenon a central importance is attributed to the absorption from injured tissues of the toxic products of autolytic changes. Fat-embolism receives brief mention, but might with advantage be given fuller consideration in a future edition. Probably too general a significance has been attributed to it by some American writers, but its occurrence may possibly throw light on the appearance of "shock" in certain cases with no obvious destruction of the tissues, and on the complete failure in such cases of efforts to restore the blood volume.

A large part of the book is devoted, as its title indicates, to the treatment of shock by intravenous injections. The theoretical considerations and experimental findings leading to the introduction of gum-acacia solution, as a substitute for the deficient blood, receive full treatment. The importance which, in certain passages, is attributed to deficient oxygenation of the blood seems scarcely consistent with what is said elsewhere as to the relatively small importance of oxygen-carrying power, in comparison with the volume and the rate of circulation of the fluid in the vessels. There seems as yet to be no evidence which would enable us to estimate the relative importance, as factors in the bad effects of a retarded circulation, of the reduced supply of oxygen on one hand, or of the defect of the mechanical flushing of the tissues on the other, by which toxic metabolites are normally swept away, possibly to be destroyed in the liver or eliminated by the kidneys. The effect on the function of the kidney of replacing blood by gum solution is not here recorded, and seems worth investigation.

Prof. Bayliss does not deal specifically with the application of conclusions, drawn from the study of "wound shock," to the "surgical shock" of civilian practice. It is to be hoped that the efficiency of his gum solution, which has done such splendid service during the war as a substitute for lost blood, will be further tested under the more rigid observation which peaceful conditions will make possible.

H. H. D.

INTRODUCTORY METEOROLOGY.

Introductory Meteorology. Prepared and Issued under the Auspices of the Division of Geology and Geography, National Research Council. Pp. xii + 150. (New Haven: Yale University Press, 1918.) Price 4*s*. 6*d*. net.

"IN the United States meteorology is included in the course of study outlined by the Committee on Education and Special Training of the War Department for Students' Army Training Units. The plan involves an intensive study of the elements of the subject in order to familiarise prospective Army officers with its chief conclusions and methods." It is to meet this requirement that "Introductory Meteorology," a work of a hundred and fifty octavo pages, including seventy excellent illustrations, has been prepared by members of the staff of the United States Weather Bureau, including W. J. Humphreys, S. P. Fergusson, W. R. Gregg, J. Warren Smith, A. J. Henry, and C. F. Talman, who are all recognised as experts in the special subjects assigned to them.

In this country no committee on education and special training of the War Department has as yet included meteorology in the course of study for Army officers, but the experience of the war has impressed upon us the necessity for setting out the elements of the subject, and the Meteorological Office has endeavoured to satisfy the requirement provisionally by the issue of the "Weather Map and Glossary" and a number of other publications. It is interesting to compare notes about these endeavours to meet a common necessity.

Though it sets out a considerable number of well-selected facts and illustrations, many of them quite novel, "Introductory Meteorology" is, from the nature of the case, little more than an enlarged prospectus of the whole scope of meteorology, including climatology and forecasting. The primary difficulty of such an enterprise meets us on almost every page, and that is to decide how much preliminary knowledge of physics and mathematics on the part of the reader is to be assumed by the author. The most effective chapter is one on "Atmospheric Optics," in which the author, with an obvious command of the subject, boldly tells the reader what he may see and what may be explained without entering into the details of explanation. There is no attempt to define refraction or diffraction. In other chapters less assurance is shown, and the author hesitates between assuming and expounding the experience

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